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DIGITAL COMPUTER NEWSLETTER

OFFICE OF NAVAL RESEARCH • MATHEMATICAL SCIENCES DIVISION

The purpose of this newsletter is to provide a medium for the interchange among interested persons of information concerning recent developments in various digital computer projects. Distribution is limited to government agencies, contractors, and contributors.

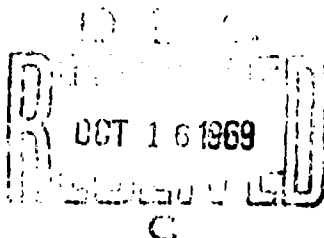
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Editorial Policy Notices

EDITORIAL

Although the Digital Computer Newsletter is a Department of the Navy publication, it is not restricted to the publication of Navy-originated material.

The publication of information pertaining to commercial products does not in any way imply Navy approval of those products, nor does it mean that the Navy vouches for the accuracy of the statements made by the various contributors. The information contained herein is to be considered only as being representative of the state-of-the-art and not as the sole product or technique available.

CONTRIBUTIONS

The Office of Naval Research welcomes contributions to the Newsletter from any source. It is through these contributions that the value of the Newsletter is enhanced as a medium of exchange between government laboratories, academic institutions, and industry.

A limitation on size prevents the publishing of all material received. Contributed items which are not published are kept on file and are made available to interested personnel within the government.

It is regretted that because of limited time and personnel it is often impossible for the editor to acknowledge individually all material received. It is hoped, however, that the readers will continue to submit technical material and suggestions to the editor for future issues.

Material for specific issues must be received by the editor at least three months in advance of the month of issue.

CIRCULATION

The Newsletter is published quarterly (January, April, July, and October) and is distributed, without charge, to interested military and government agencies, to contractors for the Federal Government, and to contributors of material for publication.

Requests to receive the Newsletter regularly should be submitted to the editor. Contractors of the Federal Government should reference applicable contracts in their requests.

All communications pertaining to the Newsletter should be addressed to:

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Computers and Data Processors, North America

B7500 and B6500 Systems

*Burroughs Corporation
Detroit, Michigan 48212*

Burroughs Corporation has announced two models of the large scale B7500 electronic data processing system and three new models of the B6500. All five models are third generation systems employing monolithic integrated circuits throughout in the central processors.

"All of the systems," said Ray W. Macdonald, Burroughs president, "are well suited for parallel processing through utilization of dual central processors, a concept pioneered by Burroughs with the B5500, and given greater emphasis in the giant multi-processor B8500."

"The new systems represent significant advances in hardware technology and design," said Macdonald, "and it is noteworthy that software for the new systems will be ready at the time the systems are delivered. Burroughs determined many years ago that hardware and software should be developed concurrently, and that they must arrive at the customer's site at the same time." He said that systems in the Burroughs 500 Systems family are upward compatible through the higher level languages they employ.

Macdonald said the B6500 and B7500 systems "are designed for business and scientific users who require continuous multiprocessing, time sharing, remote communications, and real time processing as normal methods of operation, in addition to conventional 'batch' processing of jobs."

The systems can accommodate more than 2,000 remotely located communications devices, such as teletypes, input and display, or other input or output units in a time sharing situation, and simultaneously be processing several other independent programs.

"The new systems provide ascending choices of processing speed and power, and options of either magnetic core memory or ultra-fast thin film memory," he said. Thin film main computer memory, developed and manufactured by Burroughs, can access 48 bits of data in 300

billionths of a second. Very fast magnetic core memory can access 48 bits of data in 600 billionths of a second.

The Burroughs president said the new systems are "very important additions to the company's family of advanced electronic computers." Within the Burroughs 500 Systems family, the B6500 and B7500 systems provide a bridge between the intermediate sized B5500 and the very large scale B8500. Other members of the family are the smaller B2500 and B3500 third generation systems.

The addition of the new systems gives Burroughs a tremendous range of computing power and versatility, from the low priced B200 upward to the B8500, one of the world's largest computer systems. Burroughs systems are at work in business, scientific, financial, and governmental installations all over the world. Rentals for these systems range from about \$2000 a month or more than \$300,000.

Macdonald described the B6500 and B7500 systems as up to ten times faster than the B5500. Purchase prices could range from approximately \$950,000 to about \$10,000,000. Deliveries are scheduled for the first quarter of 1969.

The central processors of all five of the systems utilize monolithic integrated circuits throughout, thereby providing faster, more sophisticated, more reliable logic systems at lower costs.

The new systems represent five steps in speed through different combinations of processor and main memory speed. The new systems include:

The B6503, with a processor speed of 2,500,000 cycles per second and a core memory access time of 600 billionths of a second.

The B6504, with a processor speed of 5,000,000 cycles per second and a core memory access time of 600 billionths of a second.

The B6506, with a processor speed of 5,000,000 cycles per second and a thin film memory access time of 300 billionths of a second.

The B7504, with a processor speed of 10,000,000 cycles per second and a core memory access time of 600 billionths of a second.

The B7506, with a processor speed of 10,000,000 cycles per second and a thin film memory access time of 300 billionths of a second.

"Our experience with the development of the B5500, and the experience of our customers in the use of this system, has proved what a really advanced computer system should be like," Macdonald said. "We have improved on the concepts of the B5500 and utilized experience with third generation techniques to produce the very advanced B6500 and B7500 systems."

B5500 users can utilize the new systems without reprogramming, and other computer users who select B6500 or B7500 systems can prepare and prove out their B6500 and B7500 programs on the B5500.

"The ability to move from one generation of equipment to another generation is of immeasurable importance to the computer user," Macdonald pointed out. "While the computer industry has made tremendous advances in the areas of hardware technology and design, there has been a significant lag in development of workable software. A company selecting a new million dollar computer may be faced with spending an equivalent amount, or often much more, in developing new programs or amending older programs for the computer to use."

"Users of large scale systems such as the B6500 and B7500 want systems to be completely responsive to their needs, and they want to be able to alter the size and nature of their systems to suit their changing requirements without the burden of reprogramming," Macdonald said.

The integration of the hardware and software design of these systems, and their modularity, permit users to make many choices among processor and main memory speeds, number and kind of peripherals, and size of main memory and data storage.

Hardware elements of the two new models of the B7500 electronic data processing system, and the three models of the B6500, work in con-

junction with the key software element, an improved, more powerful Master Control Program (MCP) derived from Burroughs years of experience with automatic operating systems.

The MCP permits the systems to control their own operations. Because they are self regulating, the systems recognize and incorporate additions of peripheral units without need for reprogramming. Among the many choices and advantages made possible by the logical design and modularity of the B6500 and B7500 models are:

- Three central processors with clock rates of 2.5, 5, and 10 megacycles.
- Core memory with read access time of 600 nanoseconds, or thin film memory with read access time of 300 nanoseconds.
- Choice of one or two central processors, each of which can access main memory. If two are used, the system can be used for parallel processing.
- Use of from 1 to 32 main memory modules, in increments of 98,304 bytes to a maximum of 3,145,728 bytes.
- One or two input/output multiplexors which allow up to 20 simultaneous input/output operations, and which control transfer of data between memory and all peripheral devices independent of the processors.
- One to eight data communication processors, permitting a very large network of up to 2048 terminal units such as teletypes, input and display systems, and others.
- In addition to data communications devices, the use of up to 255 peripheral units including card readers and punches, printers, vertical tape units, and four-station tape clusters, and up to 50 billion bytes of data storage in disk files and data memory banks.
- Real time adapters for each multiplexor to allow communication with such devices as process control systems, rocket test stands, and other real time operations.

Time sharing is a multiprocessing function for the B6500 and B7500. All the hardware required for efficient time sharing—large and fast main memory capacity, fast mass storage, independently functioning processors and multiplexors, and interval timers set in microsecond intervals—is monitored by the system's MCP, which gives the systems the advantage of being able to maintain a time-sharing network while

handling large volumes of on-site work. At a given moment, a B6500 or B7500 may be processing a payroll, performing a matrix calculation, running a simulation program, compiling programs, processing remote order entry and inventory management, and serving the users of a time sharing system. The MCP, key to multiprocessing and the most advanced among automatic operating systems, controls scheduling and loading of programs, the dynamic allocation of memory, assignment of peripheral units, initiation of input/output operations, maintenance of a log of system operation, and communications with the operator.

All programs for the B6500 and B7500 are written in compiler languages, providing the user with a simplified method of program writ-

ing. Programming languages of the two systems include (COBOL (Common Business Oriented Language), FORTRAN (FORMula TRANslation), and ALGOL (ALGOrithmic Language) and provision for any further higher level languages which are developed for general use in the areas of scientific and engineering computation, or business and financial data processing.

A significant innovation for the B6500 and B7500 is re-entrant code, which permits multiple users to have access to the same program at the same time. Main memory allocation is conserved because there need be only one copy of the program in memory. Multiprocessing takes advantage of the re-entrant feature and is the key to practical, workable time sharing.

Pattern Recognition Computer

*Cornell Aeronautical Laboratory, Inc.
Buffalo, New York 14221*

Cornell Aeronautical Laboratory, Inc. (CAL) has made two significant additions to its pattern recognition and image processing computer facilities.

The CAL Pattern Recognition Computer (PRC), first operational in 1965, has recently undergone major augmentation. In addition to a considerably expanded instruction set and magnetic-tape-handling features, the PRC now has three analog audio-frequency signal (pattern) input channels and an analog output (response) channel for time signal recognition and learning control systems research. The PRC is a closely meshed combination of a small general-purpose computer (4 microsecond add-time and 1024 words of memory) and a high-speed, special-purpose (wired program) computer which implements recognition calculation by processing connections in the recognition structure sequentially at one-million connections per second. By programming the 18,000 word special-purpose data store, a wide variety of multiple-layer linear or piece-wise linear classifiers can be employed, as can a variety of minimum-distance and statistical-decision classifiers. The training algorithm resides in the general-purpose

subsystem and is thus subject to change, as desired, by programming. The PRC is a research tool which should be easily modified, and as such, is not miniaturized. It is also designed for general capability in high-speed pattern recognition and is thus not limited to any one class of recognition techniques.

The second major addition at CAL is a PDP-9 computer (manufactured by Digital Equipment Corporation) which will be used as a real-time image pre-processor between CAL's Flying Spot Scanner and the Pattern Recognition Computer. The PDP-9 will perform the function of scan control, dynamic thresholding and filtering, image segmentation, and normalization. It will transmit patterns to the PRC for classification. The resolution (95 percent modulation) of the Flying Spot Scanner is 1024 x 1024 points with 64 levels of gray and it is a point-wise random access device. Acquisition of the PDP-9 completes a configuration permitting real-time implementation of all functions of spatial pattern recognition without the use of the central CAL scientific computing facility.

GE-600 and GECOS Operating System

General Electric
New York, New York 10022

The GE-600 product line is a family of high-performance information systems designed for large-scale business, scientific, and real-time applications. The initial offerings of this family are the GE-635, which has a 1-microsecond memory cycle, and the GE-625 which has a 2-microsecond memory cycle.

Two major goals of an information processing installation are increased throughput and reduced turn around time, measured against the cost of the equipment. The GE-600 family of computers achieves these goals through an integrated user-developed and user-oriented hardware-software system. The system's efficiency is accomplished by advanced operation techniques including standard multiprogramming capability and system design for multiprocessing.

The hardware is completely modular, permitting expansion in many combinations to meet changing requirements. Major system modules are memory, processor, and input/output controller. The system has many features that are used by the advanced software system to make multiprogramming and multiprocessing easier. The GE-600 family is priority interrupt oriented, and has complete facilities for memory protection and data communications.

The software is founded upon the General Comprehensive Operating Supervisor (GECOS)—one of the most complete executive routines in the industry. All software packages, including standard compilers, operate in conjunction with GECOS sharing input/output supervision and file/record control.

A complete line of peripheral devices for a wide spectrum of applications is offered, including a high-performance mass storage device which is used effectively to optimize software performance.

MULTIPROGRAMMING FEATURES

- Dynamic memory protection
- Dynamic program relocation
- Multi-level program interrupt
- Dual mode processor (master and slave)

MULTIPROCESSING FEATURES

- Control/subservient processor relationship
- Direct addressing throughout memory by each processor and I/O controller

- Individual memory protect for processors
- Individual memory protect for I/O controller channels
- Logical assignment of memory modules

TAILORED SYSTEMS DESIGN

- Modular hardware components
 - Selection of memory speeds and sizes
 - Selection of compatible processors
 - Selection of input/output channels per system

- Modular software design
 - General Comprehensive Operating Supervisor (GECOS)
 - Common input/output supervisor
 - All input/output is source and destination independent
 - File and record control program
 - Centralized control on all interrupts

MEMORY FEATURES

- Memory speed and word size
 - GE-635 with 1-microsecond total cycle time
 - GE-625 with 2-microseconds total cycle time
- Two words (74 bits) transferred per memory cycle
- Word size—36 bits plus parity bit

- Modularity
 - Up to 262,144 words of directly addressable memory
 - One to four memory controllers per system
 - One or two memory banks per memory controller
 - 32,768 or 65,536 36-bit words per memory bank

- Other features
 - Eight memory channels per memory controller
 - Each memory channel may be used for a processor, an I/O controller, or real-time device
 - Total file protection for processors, I/O controller, and real-time devices
 - Zone control provided for character handling
 - Memory locations may be used as accumulators

PROCESSOR FEATURES

Floating point

- Eight-bit exponent
- 28 and 64-bit stored mantissa with extended computation precision to 72 bits
- Separate addressable exponent register
- Compare and inverted divide instructions

Extensive address modification techniques

- Eight index registers plus other register indexing
- Indirect pointer to any level with tally
- Multilevel indirection with index modification
- Direct operands from address field of instruction

Logical and control instructions

- Character addressing with count control
- Binary to BCD convert instruction
- AND, exclusive OR, inclusive OR to any register and storage
- Compares: arithmetic, magnitude, logical, masked, and with limits
- Repeat, repeat double, and repeat link for sequential and threaded list processing

Protected executive software control instructions

- Load and store program relocation and memory protect register
- Load and store timer register
- Mask I/O priority interrupt register
- Mask processor interrupt conditions
- Mask memory access register
- Set master and slave processor modes

INPUT/OUTPUT CONTROLLER FEATURES

Performance characteristics

- 1.6 million characters per second throughput per controller
- 16 simultaneous channels per controller
- Six 400,000 character-per-second channels
- Ten 25,000 character-per-second channels
- Up to four I/O controllers per single memory controller

Programming characteristics

- Macro instruction processor
- Four levels of I/O interrupts
- Direct addressing of all memory modules
- Memory protect for each I/O channel
- Complete parity checking

SYSTEMS PROGRAMS

System efficiency is the result of four important principles:

1. Software was written from a "user" standpoint;
2. Software works hand-in-glove with unique capabilities of the hardware;
3. Software is mass-storage oriented to improve system operating speed and throughput;
4. Software is data communications oriented for integration of the data communications and data processing functions.

General Comprehensive Operating Supervisor (GECOS)

- Controls multiprogramming and multiple activities
- Expedites job processing
- Built-in, on-line media conversion
- Minimum operator intervention
- Absolute control of all I/O activities
- Standard checkpoint and restart procedures
- Source and object time debug
- Adaptive scheduling algorithm
- Job accounting included for multiprogramming
- Modularity allows incorporation of user sub-programs

Language processors

- Macro Assembly Program and loader
- COBOL-61 extended, with report writer and sort
- Sort/Merge
- FORTRAN IV
- SIMSCRIPT

Applications

- LP/600
- APT
- PERT/Cost
- MATH library

Data communications/real-time control

- Efficient processor for programming
- DATANET* applications
- Message switching, routing, and queueing
- Program integration with GECOS
- Direct, quick response from desk-to-computer-to-desk

*Registered trademark of General Electric Company

INPUT/OUTPUT EQUIPMENT

Magnetic tape subsystem

7/9 track recording
2 x 16 and 2 x 8 crossbar controllers
120/83/30 thousand characters per second transfer rates
800/656/200 bits per inch
1/2 inch compatible

Magnetic drum storage

370,000 characters per second transfer rate
786,432 36-bit words per drum
17 millisecond average access

PR-20 printer

1200 or 900 lines per minute
10 characters per horizontal inch
Six or eight-lines per vertical inch
Vertical and horizontal paper alignment
ASCII graphic character set

CR-20 card reader

900 cards per minute
Hollerith, binary, or intermixed modes
Validity check on Hollerith codes

CP-20 card punch

Hollerith or 12-row binary cards
100 cards per minute
Reader-after-punch check

Consoles (master and auxiliary)

Operate as peripherals to the system
Master console has hardware status indicators
Multiple supervisory consoles for operator/software system interaction

TS-20 perforated tape reader/punch

Read, punch, spool 5, 6, 7, 8 level
Reads 500 characters per second
Punches 150 characters per second
Plugboard for format control on input

Custom peripherals available

Digital plotters
Real-time interface controllers
CRT display

DATANET-30 data communications processor

Stored program, single address computer
Core memories to 16,384 28-bit words
7-microsecond memory cycle
Up to 128 I/O communication channels
Bit, character, and word channel options
Elapsed time counter
Indirect addressing and multiple index registers
Memory interrupt

DSU-270 mass storage subsystem

Fast, fixed-head, disc storage units
Single or dual controller
Up to four file electronics crossbars to one or two controller channels
Up to five disc storage units for each file electronics unit
Seek time—0 microsecond (fixed head)
Average latency—26 microseconds
Minimum capacity 15.36 M usable characters
Maximum capacity 307 M usable characters
Data rate 333 KC

GECOS III

General Comprehensive Operating Supervisor III (GECOS III) efficiently integrates requirements for on-line batch, remote batch, and time-sharing into one system using a common data base.

The "heart" of GECOS III is a centralized file system of hierarchical, tree-structured design which provides multiprocessor access to a common data base, full file protection, and access control. It offers full user program compatibility with GECOS II, but its internal organization and logic flow are completely new. It provides significant improvements in the performance and reliability of the multiprogramming, multiprocessing, and remote processing function of GECOS II, but also provides concurrent time-sharing capabilities with BASIC language and text-editing functions.

With the new operating system, the GE-600 "family" of computers now offers users the ability to mold their varied data processing and access requirements into a truly integrated system. The problems of employing multiple systems, with incompatible programs and files, no longer need exist for large-scale computer users.

Through the use of GECOS III, the ease with which a system may be extended and modified has been enhanced greatly.

GECOS III consists of three distinct elements, or types of routines:

1. A resident executive (known as the "hard core monitor").
2. A small number of "system programs" (such as the job input processor) which perform services for the community of user programs within the system.
3. A library of system subroutines which perform service functions (such as I/O) for individual user programs.

At system initialization, the hard core monitor is loaded into memory, and remains intact throughout GECOS III operation. It contains system configuration data; interrupt processing routines; fault processing routines; the "dispatcher," which allocates the processor; and the most heavily used system service sub-routines.

All memory, except the hard core monitor, is occupied by programs from user-submitted jobs and by a few system programs, such as job input processor, peripheral allocator, core allocator, and standard output disperser.

These system programs concern the functions of introduction, preparation for execution, and dispersal of results of a user program. There is only one distinction that the system makes between user programs and system programs. System programs need to reference common data such as the system configuration, held in tables in the hard core monitor; therefore, a special entry point to the hard core monitor is provided to allow such a reference. Programs which are permitted to use this entry point are "privileged" programs. The time-sharing system and the test and diagnostic system also are privileged system programs, and are allowed this privilege in order to achieve high speed I/O interfaces and interior memory protection. If a user program attempts to gain entry, that program is aborted.

GECOS III provides true device independence. The I/O structure is defined so that user programs reference logical files and need not be concerned with physical device peculiarities. Association of logical I/O requests with a specific device only occurs when the physical I/O operation is initiated. Thus, a data file can be moved to a different device whenever necessary.

The GECOS III time-sharing system is designed for installations that have a batch processing commitment and also need time-sharing.

The portion of the hardware dedicated to time-sharing is dynamically variable, providing an operating spectrum from full time-sharing through full batch processing, according to the specific requirements of the installation.

The time-sharing executive performs the functions of selecting, allocating, dispatching, and swapping time-sharing user programs. Since the time-sharing executive is treated as a single system program by GECOS, it sub-allocates memory and sub-dispatches the processor to individual time-sharing user programs.

The time-sharing executive also performs various services for individual programs, including file system I/O, terminals I/O, and creation and modification of files, catalogs, and their security definitions; and it accounts for resources used by the individual time-sharing users.

One of the major integrating factors in the design of the time-sharing system is the use of the GECOS file system. It is through this common file system that user programs in the batch system and in the time-sharing system communicate with each other.

A straightforward application of this capability allows a large batch job to generate or update a file (perhaps based on inputs from another file entered from time-sharing terminals) and have the updated file available for inquiry by time-sharing users.

An even more interesting capability allows the time-sharing system to generate a job for the batch system. The user program in the batch system may be too large to process conveniently in the time-sharing mode, or may be an existing program for which modification for direct execution in the time-sharing mode is not desirable. An option exists to allow a time-sharing program to wait for the completion of a batch job. In addition, there can be a direct "conversation" between a batch program and a remote terminal.

Computing Centers

New IBM 360/75 for Biomedical Research

*University of California, Los Angeles
Los Angeles, California 90024*

More than 300 medical research projects—including studies of brain surgery, kidney transplant, cancer, and microscopic X-rays—are advancing with the aid of an extremely powerful computer at the UCLA Center for Health Sciences.

The UCLA computing facility—already one of the nation's largest data processing centers for biomedical research—now has expanded capability with its new IBM System/360 Model 75.

Television-like devices will be used to communicate with the new system to graphically display information. For example, microscopic X-rays of chromosomes will be stored in digital form within the system and shown on the device's cathode ray tube with the press of a button.

The multimillion dollar computing facility was made possible by a grant from the National Institutes of Health. It was originally established in 1963 with IBM 7040 and 7094 computers, now replaced by the Model 75, one of the largest systems presently available from International Business Machines Corporation.

Six West Coast research institutions are linked to the UCLA facility in a teleprocessing network that permits them to use the computing equipment, and to exchange medical information. The institutions include: Oregon Research Institute, Eugene; Presbyterian Medical Center, San Francisco; University of Southern California Medical School, Los Angeles; Loma Linda University, Loma Linda; Rancho Los Amigos Hospital, Downey; and Pacific State Hospital, Pomona. Other institutions are planning to join the network.

"The Health Sciences Computing Facility has long been a leader in developing theory and methodology to enhance computer research efforts of medical science," Dr. Wilfrid J. Eixon, facility director said. "The well known Biomedical Programs Package (BMD), developed by the staff, is being used all over the country."

TYPING WHITE BLOOD CELLS

Among the many research projects using the Model 75 is an international program of typing of white blood cells, under the direction of Dr. Paul Terasaki of the UCLA Medical School's surgery department, in cooperation with Dr. M. R. Mickey of the facility staff. Aim of the project is to determine if white blood cells may be typed as an indication of tissue compatibility in transplants of kidneys and other organs, just as red blood cells have been typed for blood transfusions for many years.

In the project, tiny containers of blood are airmailed from 14 organ transplant centers throughout the world. The blood from both the donor and the recipient is subjected to about 600 different tests in Dr. Terasaki's laboratory. The System/360 processes the results which are studied by doctors to determine tissue compatibility. The computer also is being used in analysis of statistical data about such organ transplants in the search for a universal method of white blood cell typing. Cooperating in the study are transplant centers in Paris, France; Copenhagen, Denmark; Sydney, Australia; Montreal, Canada; and in this country centers at Harvard Medical School, University of Colorado, Medical College of Virginia, and seven other prominent medical institutions.

BRAIN WAVE STUDIES

An investigation of the intricate process of how the brain stores and retrieves information is being conducted by Dr. W. Ross Adey and Donald O. Walter of UCLA's Brain Research Institute. "Computer analysis of brain waves has tremendously accelerated growth of the knowledge of brain function," Dr. Adey said. "Brain waves have been recorded for more than 80 years in the form of electroencephalograms," he pointed out. "But not until large computer systems were applied to them was it possible to analyze subtle patterns which denote informational transactions in the brain."

While largely concerned with a basic understanding of informational processes in the brain, the investigation is being practically applied to problems of brain function and behavior in the hostile environment of space and in treatment of neurological diseases. Already these computer techniques are being used to plot brain surgery in difficult cases of epilepsy and other neurological diseases. The study has been also extended to mental illness.

HOSPITAL PROCEDURES

As the result of an extensive research project at the Health Sciences Computing Facility, computers are performing a variety of chores for the UCLA Hospital. These include compiling, storing, and retrieving records on clinical, chemical and bacteriological procedures, hospital accounting, patient billing and maintenance of a master patient identification file.

The recording system for patient laboratory tests includes more than 300 procedures. Laboratory technicians record results on mark-sense cards identified by patient name. At the end of each day all results are assembled and the computer edits, sorts, and prints them out for patient charts. In about 15 minutes, the high speed computer-controlled printer produces 900 to 1,200 separate chemistry reports

each day for the requesting physician, nursing station, or clinic and patient chart.

INTERPRETING X-RAYS

A project under the direction of Drs. Amos Norman and Harvey Frey, of the radiology department, is studying the use of the computer to assist in the interpretation of X-rays. The IBM 2350 display unit is used to study microscopic X-rays of chromosomes as follows:

The X-rays are electronically scanned and converted into a series of digits that can be stored in the Model 75 or on magnetic tape. They also can be retrieved and projected onto the cathode ray tube of the 2250. In this way chromosomes can be classified and any abnormal differences in their shape may be correlated to various diseases or genetic disorders. In time the computer may enhance the image of X-rays of the lungs and skull. Subtle differences in light and shadow, not always discernable to the trained eye of the radiologist, may carry important diagnostic information. The computer may eventually assist the radiologist in recognizing these subtle differences.

The graphics system also utilizes tumor registry. Various facts about cancer, such as geographic incidence of cancer by age and sex can be retrieved from the computer file on command and displayed on a large scope.

Expanded Dartmouth Time-Sharing System

*Dartmouth College
Hanover, New Hampshire*

Eighteen Northern New England secondary schools are linked experimentally by teletyp to Dartmouth College's time-sharing computer system. The aim is to discover how a large-scale computer facility can best be used as a broad aid to secondary education, generally.

If the experiment is successful, the knowledge of operations and teaching techniques will be shared with other computation centers which seek to serve secondary schools in their regions. In support of this, Dartmouth received a grant (\$142,500), from the National Science Foundation, which will enable the secondary schools to have teletype consoles connected to Dartmouth's Kiewit Computation Center by long-distance telephone lines. The link-up will give the students quick and easy access to a multimillion dollar General Electric 625 computer by simply completing a telephone call. Through the time-sharing system, up to 200

callers will be able to use the computer simultaneously with little apparent delay because of the computer's extremely high speed. At the same time, Dartmouth students and faculty members can be using the computer for their class work and research. The students will be taught an easily understood computer language called BASIC which was developed by Dartmouth mathematicians.

Seven of the 18 schools have been connected to the computer in the years since time-sharing was started at Dartmouth in May, 1964. They are: Phillips Exeter Academy, Exeter, N. H.; St. Paul's School, Concord, N. H.; Mount Hermon School, Mt. Hermon, Mass.; Vermont Academy, Saxtons River, Vt.; Phillips Academy of Andover, Mass.; Hanover High School, Hanover, N. H.; and Mascoma Valley Regional High School, West Canaan, N. H. Joined with them through the NSF grant are Manchester Central

High School, Manchester, N. H.; Keene High School, Keene, N. H.; St. Johnsbury Academy, St. Johnsbury, Vt.; Lebanon High School, Lebanon, N. H.; Timberlane High School, Plaistow, N. H.; Hartford High School, Hartford, Vt.; Concord High School, Concord, N. H.; Rutland High School, Rutland, Vt.; South Portland High School, Westbrook, Maine; Cape Elizabeth High School, Cape Elizabeth, Maine, and Loomis School, Windsor, Conn.

Professor Thomas E. Kurtz, director of the Kiewit Computation Center at Dartmouth and director of the secondary school project, explained the secondary-school project this way: "We start from the premise that in the lifetime of today's students the use of computers will become as much a part of everyday life as the telephone or automobile. But few secondary schools, especially in non-metropolitan areas, can afford their own expensive computer installations. Our experience with the secondary schools showed us that while students might know little about the computer itself, they could develop a familiarity with computing technique that would allow them to use it in their everyday work. And once they experienced the practical application of computing, any uninformed apprehension they might have had would be dispelled: their judgments concerning it would be more rational, and they would be ready to pursue their education and careers with confidence and competence."

As an example of the sometimes-startling results achieved by the students, Professor Kurtz cited Hanover High School's extracurricular Computer Club. Several hundred students have joined, and one group prepared a program in BASIC language which plays chess. A bright fifth grader, working on his own, produced a program for generating magic squares and another for factoring integers. Another student developed a program that composes Japanese haiku poetry.

At Phillips Exeter Academy, the computer is used extensively in several courses including mathematics, physics, and chemistry. Arrangements have been made for students to arise at 4 a.m. to make use of the otherwise idle teletype console.

At Mount Hermon School more than 400 students were trained in the BASIC language on one teletype during the fall term.

But despite the general enthusiasm in the schools and the reports of innovative uses, Professor Kurtz continued, the results of the computer experiments in secondary education had not been examined. "We have no detailed descriptions of the use of the computer in particular courses, the recommended procedures for forming computer clubs, or examples of exercises and teaching units found to be useful," he added.

"Our purpose in applying for the grant, then, was to permit developing, expanding, sharing, documenting and publishing the results of this experience."

As a preliminary to the program last fall, teachers from the 18 schools attended Dartmouth for a 4-week course in computing techniques, including the BASIC language.

Three other teachers from the South and Midwest also attended the conference under the sponsorship of the Pillsbury Company of Minneapolis, Minn. They are Mrs. Rene Chandler, a teacher at Therrell High School, Atlanta, Ga.; H. Murray, Jr., of Needham-Broughton High School, Raleigh, N. C., and Prof. Milton Brostrom of Gustavus Adolphus College, St. Peter, Minn.

The Pillsbury Company operates computer centers in these cities and experiments with secondary schools are being planned there too.

The program's associate director, Prof. William E. Slesnick of Dartmouth, is assistant director for education in the Kiewit Computation Center. For 10 years before coming to Dartmouth in 1962 he was mathematics master at St. Paul's School in Concord, N. H. He is the author or coauthor of several mathematics textbooks and is frequently called on to discuss or consult on matters of education in mathematics.

Most of the teaching is being done by John C. Warren, instructor in mathematics at The Phillips Exeter Academy. He was instrumental in establishing the computer teaching at the academy.

Time-Sharing Expansion

*IIT Research Institute
Chicago, Illinois 60616*

Development of computer time-sharing techniques and software is being expanded at IIT Research Institute under an agreement with Allen-Babcock Computing, Inc., Los Angeles, according to Albert K. Hawkes, Director of the Computer Sciences division at IITRI. The agreement extends to IITRI the use of the firm's time-sharing computer system called RUSH (Remote User Shared Hardware), which is a conversational programming system for the IBM System/360. RUSH was recently developed by Allen-Babcock to combine the best and most usable features of the FORTRAN, COBOL, and ALGOL programming languages, according to Mr. Hawkes.

RUSH will be used at IITRI in developing techniques for on-line applications in such areas as operations research, civil engineering, and financial data processing. It is also intended that IITRI will develop on-line computer techniques for individual Computational Services' clients in other areas of application.

IITRI also plans to make general RUSH service available to clients via telephone data-links. The RUSH system will be an added serv-

ice to IITRI's Computational Services Center, which will continue to provide its present large scale scientific and engineering computer services to industry and government agencies.

The RUSH system has demonstrated utility in commercial as well as in scientific and engineering applications, Mr. Hawkes said. During program input there is immediate feedback when an error is encountered, and during processing, program errors are flagged immediately, he said.

In addition to powerful algebraic capabilities, including nested loops and subscripted arrays, the RUSH system has instructions for handling character strings and extensive file manipulation. A specially designed set of micro-instructions to make execution of RUSH programs very efficient on the IBM 360 Model 50 computer has been incorporated in the system.

IITRI RUSH terminals also will provide access for remote job entry to conventional System/360 batch operations run in the background during RUSH operations.

Computers and Centers, Overseas

Advanced On-Line Computer Banking System

*English Electric-Leo-Marconi Computers Ltd.
London SW1, England*

All branches linked directly to computers by early 1971 is the target Midland Bank has set in plans for what will be the world's largest and most advanced on-line computer banking system. The scheme which will initially cost several million pounds has been planned around English Electric Leo Marconi's System 4-70 computers—six of these machines, installed in pairs at three centres in London, Leeds, and Liverpool (with possibly a similar centre in Birmingham) will form the bedrock on which the Bank will build its expanding customer services.

The computer centres will be linked to branches via leased telephone lines and will themselves be interlinked on a ring-main concept, so that a customer banking in Liverpool, say, could go into a branch in Brighton and cash a cheque as if he were in his own branch. This facility would eventually be available at any one of the 2650 or so branches of the Bank.

Other schemes in other parts of the world for on-line banking systems are either much smaller (only the French banks can compare in terms of number of branches) or more limited in application. The Americans are using computers on-line to banks, but only for savings' bank applications, covering a relatively small number of branches and a relatively small area. The scheme proposed by Midland Bank is far and away more ambitious, since the real-time computer terminals in the branches will replace the actual accounting machines and not be used just for up-dating passbooks, as in the American system. The scheme will, in fact, form a national computer grid of the type foreshadowed in the Flowers' Report, the government's blueprint for future computer development.

To operate such a scheme requires very fast computers with very fast interrupt times, since the more terminals on-line to the centres the greater, of course, the peak load is likely to be. It does, in fact, require third generation machines of the power of the large System 4-70s. These machines are at the top end of the System 4 range, which is the first computer range in the world to use micro-integrated circuitry in all central processors.

The demand for these large machines since their announcement has been considerable. Five 4-70s have been ordered by the GPO (two for the Giro service), with an option for four more; two are going to the Ministry of Social Security at Newcastle for use on pensions; the Ministry of Transport will take another for work in road research and road safety; and another will go to the North West Electricity Board in Manchester.

The use of a computer network of the type planned by Midland Bank will enable the Bank to contain banking costs and also to extend considerably its range of customer services. At present, a very high proportion of the cost of the average banking transaction is made up of labour costs. The use of computers on this scale will increase the "hardware" content of costs and keep labour costs, which are less predictable and rising, to a minimum.

The Midland Bank has already ordered two System 4-50 computers and a System 4-10 for use in the North of England. Delivery of the 4-50s to Liverpool and Leeds is due in the summer and autumn of this year and the 4-10 will follow in Manchester early in 1968.

I. C. T. Software

*International Computers and Tabulators Limited
London SW13, England*

ALGOL and FORTRAN

ALGOL and FORTRAN programs can now be compiled on the smallest computers in the I.C.T. 1900 Series range. This has been achieved without restricting the facilities of either language in any way. Special compilers, inevitably dubbed mini compilers, have been developed for this purpose and will be available shortly for use with 1900 Series computers having core stores of 4096 words capacity. No supplementary backing store is required.

Source programs prepared in ASA basic FORTRAN (FORTRAN 2) and IFIP ALGOL can be handled. In fact the two mini compilers can process languages with facilities that are somewhat better than ASA Basic FORTRAN and a version of ALGOL that includes IFIP ALGOL as a subset and has additional features such as recursion.

Mini compilers are suitable for handling small scientific and engineering programs, especially where iterative or recursive calculations are involved, and for such work as the preparation of short statistical routines. They will also prove to be of great use in the training of programmers—the diagnostic facilities available with the mini compilers will be of special value in this context.

More powerful versions of Mini ALGOL and Mini FORTRAN are being developed for small 1900 installations that possess data storage capacity additional to the basic 4K core store, such as cassette tape units or exchangeable disc stores.

In order to be able to handle ALGOL and FORTRAN programs on a computer with a 4K core store, a new method of compiling had to be devised. The conventional procedure is to load the complete compiler into the computer and read in the source program, one statement at a time, translate the source program instructions into the equivalent machine code instructions and then either hold the derived object program in store, or record it on magnetic tape, or punch it out in paper tape or cards. With the mini compilers the procedure is the exact reverse of this. The complete source program is read into the computer and held in the core store and the compiler, previously divided into sections, referred to as overlays, is read into the computer, one overlay at a time.

Source program statements are examined and partially converted by the particular compiler overlay in the machine at that time. Then the next overlay is read into the computer's store, overwriting the previous one and the incremental compiling procedure is repeated. Finally, when the last overlay of the compiler has been handled, a complete compiled object program remains in the store ready to be executed immediately.

The compiler overlays and the sequence in which they are read into the computer have been arranged so that any legal FORTRAN or ALGOL source program can be compiled. Mini FORTRAN comprises 29 overlays—Mini ALGOL has 34 overlays.

Mini ALGOL and Mini FORTRAN compilers can be used on any 1900 Series computer equipped with a paper tape reader, a line printer and a core store of 4096 words capacity. The compiler is read into the computer from punched paper tape. On the printer a list is produced of the source program statements together with line reference numbers. During the compilation procedure an error commentary is printed out, the line reference numbers being used to identify the location of mistakes.

Naturally this particular compilation procedure possesses certain limitations and also certain advantages over, what might be termed, traditional compilation techniques. First the size of the source program that can be handled is obviously restricted by core storage capacity. Broadly speaking of the 4000 words of store available, 2000 are required for the computer's Executive program, 1000 words are needed for holding one overlay of the compiler, leaving 1000 words free for the compiled object program. This means that source programs of 70 to 80 statements are about the largest that can be accommodated.

Several advantages, do accrue, however. Firstly, because the complete source program is in the computer, in practice this makes error detection easier. Good error detection facilities are provided in the mini compilers. Secondly, there is no limit to the size of the compiler, consequently extra facilities can be added, if required, merely by the addition of further overlays. Furthermore, any developments improving the efficiency of the compiler can readily be incorporated.

For load-and-go runs the compilation time required using mini compilers compares favourably with that for conventional compilers. Since a slow peripheral—a paper tape reader—is used to enter the mini compiler overlays into the computer, this effectively determines the speed of the compilation procedure. When a mini compiler is used on a 4K machine for converting a source program of 70 or 80 statements, the compile time is of the order of 5 to 6 minutes.

With the introduction of Mini ALGOL and Mini FORTRAN, ALGOL and FORTRAN compilers are now available for all 1900 Series computers, from the large to the small.

PATSY

PATSY (Program Automatic Testing System) is a suite of programs which simplify, accelerate, and generally improve the efficiency with which program testing work can be performed. PATSY enables batches of source programs written in PLAN, COBOL, or NICOL to be amended, compiled, and run with test data with the minimum of operator intervention.

The batch of programs to be processed is assembled on a magnetic tape file, and the programs are then dealt with in sequence in one continuous compilation and testing procedure. Details of any errors detected in particular programs of a batch are printed out for the programmers to correct.

PATSY reduces turn-around time for programs under test, minimizes magnetic tape handling and reduces computer set-up times.

PATSY has three operational phases—editing, compiling, and testing.

During the editing phase, a master source file is first created on magnetic tape. This file comprises the source programs to be compiled and tested; test data representing the file information to be manipulated by the object program; and control information specifying, for instance, how post-mortems of particular types of detected error are to be presented.

Amendments can be incorporated in the original source program or test data supplied during the editing phase. If a master source file has already been created it can be updated at this stage. Should an error be detected while incorporating amendments, error messages are printed out for the guidance of the programmers. A copy of any source program may be

produced on magnetic tape, cards, or paper tape at this stage, on request.

All the source programs and their associated test data in the batch to be tested are assembled on the one magnetic tape of the master source file.

Next is the compile phase. Source programs written in PLAN and COBOL are read one at a time from the master source file and consolidated, semi-compiled object programs are produced with their appropriate leaders. Due to the nature of the NICOL compiler it is called in separately whenever a NICOL program is to be compiled.

The final operation in the compile phase is to consolidate the semi-compiled object programs and write fully compiled object programs together with their test data onto the testing file magnetic tape.

Finally in the third phase—testing—the titles of the programs to be tested are supplied to the computer on cards or paper tape. Object programs are tested in the order the titles are presented.

At the beginning of each test the test data supplied are fanned out and written on work tapes to simulate the files with which the object program will operate. Provision has been made for test data to be entered by punched card or paper tape input readers, or by the operator via the computer's console typewriter, should such facilities be required. The object program is then performed and, when requested, post-mortem print-outs of core-store or magnetic-tape data files are produced under the control of PATSY.

PATSY can be employed on any I.C.T. 1901, 1902, or 1903 computer installation equipped with an 8K core store, a console typewriter, four magnetic tape units, a line printer, and a paper tape reader or card reader.

Two versions of PATSY are available: PATSY 1 is designed for use with I.C.T. cassette tapes and PATSY 2 for other magnetic tape systems.

COBOL

It has for some time been possible to program a computer using simple English statements. By using a special program, known as a compiler, the computer itself could be made to do the work of translating the original English

instructions into its own "machine-code" language of 0's and 1's. But in the past, this "compilation" took up so much of the computer's valuable time, and the final programs were so inefficient, that the applications of a simple English programming language were limited.

Now I.C.T. has exploited both the speed of its successful 1900 Series computers and the experience of its software writers to develop compilers which are over 70 times faster than those previously available. The new compilers translate programs written in COBOL—Common Business Oriented Language—into a form suitable for processing by 1900 Series computers. COBOL is a commercial programming language composed of a limited number of standardised English statements like "MULTIPLY HOURS BY RATE GIVING GROSS PAY" which can be used to describe most commercial data processing routines.

Computer users are therefore now able to benefit from writing programs in ordinary English with little or no sacrifice of computer time or program efficiency. COBOL programs can be written, proved, and running far more rapidly than programs written in other languages. And since it is a standard language, COBOL enables programmers to transfer readily from one computer to another. Apart from obvious flexibility, this results in a marked reduction in training costs. Moreover, programs written in COBOL are so well documented that continuous program development is possible in spite of staff changes.

The high compilation speeds possible with I.C.T. 1900 COBOL compilers mean that all program testing and subsequent modifications can be carried out in the source language itself,

that is, in COBOL. The source program can then be re-compiled in a matter of minutes and the COBOL programmer need never know the nature of the program as it is obeyed by the machine. This significant reduction in program testing time, allied to the fact that programs can be written in less than half the time taken when using assembly language, results in marked savings in overall programming costs. Yet the final program running time is only marginally increased over an equivalent program written in "assembly" language (a language in which each machine code instruction is represented by a more easily remembered mnemonic code).

Two 1900 COBOL compilers have been developed by I.C.T. These are Compact COBOL, which has been developed for the benefit of users with smaller 1900 Series computer, and Full COBOL for larger 1900 systems. Both are designed for maximum speed of operation of the final object program, while keeping the core store requirements to a minimum. Source programs written in Compact COBOL can be compiled on an I.C.T. 1902 computer equipped with an 8K store and four magnetic tape units at a nominal rate of 50 statements a minute. Given a 32K store, Full COBOL can be compiled at the rate of 800 statements a minute.

Finally, I.C.T. COBOL has an important technical advantage common to all I.C.T. 1900 Series programming languages. Different segments of one program can be written in different languages and compiled into one program. Therefore each segment can be written in the language most suitable to it. Moreover, separately compiled sub-routines from a program library can also be incorporated into the final program.

Miscellaneous

Computerized Pathology Information

*Armed Forces Institute of Pathology
Washington, D.C.*

In 1967 a computer devoted to the science of medical pathology went into operation at The Armed Forces Institute of Pathology. Major General Joe M. Blumberg, the Director, AFIP, said the computer could mean the difference between life and death in urgent cases. Also, he said, it will speed up research which was heretofore slow and arduous.

General Blumberg said the computer center will serve Department of Defense hospitals, Veterans Administration hospitals, civilian hospitals, and other federal medical facilities and more than 8,000 civilian pathologists.

Lieutenant Colonel N. R. Cheek, MSC, USA, head of the Automatic Data Processing Service, explained that AFIP, as an international center of pathology, receives more than 50,000 requests each year from pathologists for consultation.

Records of about 1,240,000 cases are stored at AFIP and are used by the staff in diagnosis and research of pathologic problems.

The computer, an IBM System/360 Model 30, has substantially shortened the time it takes to get vital information into an AFIP pathologist's hands. Index information and brief records on subjects requested by pathologists—to steer them to detailed medical reports—are delivered by the computer in a day or less. Getting this information, which can go as high as several thousand cases, previously took up to a week.

Mr. Lee C. Taddonio is chief of the computer center.

Initially, data fed into the computer will be coded. Within a year, AFIP will experiment with a new system to replace coding. The innovation will incorporate automatic indexing and a

greatly-expanded record with a natural language input technique.

LTCOL Cheek said, "The vocabulary of pathology, as it is used for morphologic diagnosis, has order and regularity and discipline.

"It is adaptable to mechanical handling and it is this feature that had made this system possible," he said.

The use of natural language instead of a computer code also is unusual. The technique has been used in medicine in the United States only at three universities: University of California at Los Angeles, Western Reserve, and Wake Forest.

"When we use natural language," LTCOL Cheek said, "we don't have to code and therefore we don't have to interpret. Interpretation gradually changes meanings."

LTCOL Cheek said the computer "will allow the professional personnel to obtain knowledge previously not available. It is felt that there is a vast amount of hidden knowledge in the pathology case records and associated materials, which is not presently available since it is virtually impossible to retrieve.

"Mathematical and scientific problems also can be solved which presently are not even attempted.

"The computer gives The Institute one of the most advanced research tools yet invented by man. Research previously impossible or so laborious that it would not be attempted now can be accomplished through the use of a computer."

The \$500,000 center will be staffed by 35 persons.

Ocean Going Computer

*University of California, San Diego
La Jolla, California 92037*

A sea-going computer has signed on for duty aboard a Scripps Institution of Oceanography research vessel.

Installation of the IBM 1800 system on board the THOMAS WASHINGTON will enable Scripps scientists to gather and act on information obtained from the sea without waiting for a return to port and processing by land-based computers.

The installation of the computer is part of a joint research project being conducted by Scripps and International Business Machines Corporation. The 1800 will be used initially in short research trips through Southern California waters as Scripps and IBM technicians study the equipment and its applications under cruise conditions.

"Ultimately, the computer will give the scientist a tool with which to achieve greater scientific knowledge more rapidly at sea," explained Dr. William A. Nierenberg, director of the University of California, San Diego's Scripps Institution of Oceanography.

"We are pleased to join IBM in this ocean-going computer program. It will give our scientists an opportunity to concentrate on interpretation and analysis of observations while at sea for planning continuing research. This will result in substantial saving of ship-operating time.

"Use of the computer could enable a chief scientist to determine whether he wishes to alter course midway in an expedition based on information collected and processed at once by the computer."

Dr. Nierenberg added, "scientists at sea would prefer to have immediate analyses of their research while the ship is still in its area of operation in order to confirm their findings before moving on to a new work station."

Dr. Bruce Taft, assistant research oceanographer at Scripps, will be chief scientist in a 55-day cruise beginning August 1, in eastern tropical Pacific waters. During the cruise, the 1800 will be used for automatic reading of ocean temperature, pressure, and salinity and for direct reading of echo-sounding measurements. The system will be able to reduce these data, analyze them, and make them available for in-

terpretation by the scientists while the ship is still on station.

Usually data collected during long research expeditions are not processed until after the scientists return to their home port.

This research cruise will be part of the Eastropac Expedition that began last January, sponsored by the U. S. Bureau of Commercial Fisheries and funded to a large extent by the Office of Naval Research. The objective of the cruise is to understand better the circulation of the eastern tropical Pacific waters and its biological populations.

The computing system is being installed in one of the ship's air-conditioned, main deck laboratories. The installation, designed to function in fair weather and foul, requires some 250 square feet of deck space.

E. H. Coughran, research staff member of IBM's Los Angeles Scientific Center, has worked closely with Scripps' Shipboard Computer Panel, headed by Dr. Charles S. Cox, professor of oceanography, in planning this installation.

"The IBM 1800 data acquisition and control system is extremely versatile," Coughran said. "It is being used to control complex scientific and industrial processes ranging from glass production and oil refining to drug research and air-pollution testing.

"This will mark its first installation aboard a research ship. The 1800 is a seaworthy scientific computer. It is capable of functioning over a wide range of temperature and humidity and will be able to withstand the ship's pitching, rolling, and yawing motions," Mr. Coughran stated.

Mr. Coughran said the IBM 1800 has four jobs on board ship:

1. To perform the regular routine logging of the marine environment, including measuring water depth, checking sea-surface temperatures and salinity every 5 minutes, if need be; calculating wind speed and direction, and taking air temperature and humidity measurements automatically.
2. To collect data for specific scientific experiments; for example, to chart temperature

and sound velocity and conductivity profiles or to calculate the biologically important properties from automatic measuring instruments.

3. To work toward a more accurate knowledge of a ship's position at sea, giving better knowledge of the origin of the data it is collecting. When satellite navigation becomes available later next year, the computer will be able to calculate the ship's position very accurately every 90 minutes as the satellite swings overhead and re-plot the ship's course if necessary.

4. To give the scientist a general-purpose computer with which to analyze previously unanticipated relationships from the reduced data. The scientist will be able to write completely new analysis programs or modify old ones while he is still at sea.

These four assignments can be carried out simultaneously on the 1800 with no interference with one another. As far as each of the four jobs is concerned, the system will operate as though there were a separate computer aboard for that job alone.

Computerized Driver Information

*State of Connecticut
Department of Motor Vehicles
Wethersfield, Connecticut 06109*

In 1967 Connecticut took a computer-assisted step toward making its roads even safer. The Motor Vehicle Department Headquarters installed a high-speed communications network linking 16 department offices throughout the state to a pair of powerful computers in Hartford.

Detailed driver information, stored in the computers' electronic files, is available at any terminal-equipped office in seconds. The computers, IBM System/360s, are part of a statewide data center complex operated and coordinated by the State Comptroller's office.

A growing abuse, and threat to safety, which the new Motor Vehicle Department system is helping to end is the obtaining of duplicate licenses by drivers who expect to have theirs suspended.

"Since Connecticut began suspending licenses for speeding," explains Motor Vehicle Commissioner John J. Tynan, "the duplicate license plot has been increasing steadily.

"It works this way—a driver, after getting a speeding ticket, goes to one of our offices and asks for a duplicate license to replace the one he says he has lost.

"The office, not knowing about the ticket, issues a duplicate. Then, if the speeder is convicted in court, he has one license to surrender and another to drive around with."

Any Motor Vehicle Department office linked to the computer by one of IBM's typewriter-like terminals can get information in seconds about

any driver's license and avoid issuing a bogus duplicate.

According to Commissioner Tynan, it is likely that State Police and the police departments of Connecticut's larger cities eventually will be tied into the network.

"The availability of up-to-date information at almost—literally—the touch of a key will be a great aid to the Motor Vehicle Department and to law enforcement agencies," the Commissioner said.

"It also should prove a benefit to the driving public as far as simplifying and speeding up the registering of vehicles and the issuing of licenses."

The communications terminals now installed at Motor Vehicle Department Headquarters here will be supplemented later this year by 16 visual display stations, also linked to the computers in Hartford. Instead of printing information out as the terminals do, the display stations—IBM 2260s—flash data on a small television-like screen.

The new terminal-computer system, is operational in all but three of the 15 Motor Vehicle Department branch offices. The 15 branch offices are located in Bridgeport, Danbury, Enfield, Middletown, New Britain, New Haven, New London, Norwalk, Norwich, Old Saybrook, Putnam, Stamford, Torrington, Waterbury, and Willimantic.

Index of Government-Sponsored Computer Projects

*National Bureau of Standards
Washington, D.C. 20234*

The NBS Center for Computer Sciences and Technology (U.S. Department of Commerce) has completed the compilation of an automated index of Government-sponsored R&D projects in the computer sciences. The index, which covers almost 2500 projects, was prepared with the assistance of the Defense Documentation Center.

As stored on computer tape, the index will be available for such representative machine searches as the listing of all projects for which a particular investigator has responsibility, or the determination of the amount of money spent by a certain agency on all projects in the com-

puter sciences. Also, the index offers a large corpus for experiments in machine indexing.

In the form of a computer printout, it is available for study at the Computer Center's Technical Information Exchange at the Gaithersburg, Md. laboratories of the National Bureau of Standards. The printout comprises two different listings. One of these is sequenced by 20 subject categories, drawn up by the Center staff especially for the field of computer sciences and technology; the other is by sponsoring organization, further arranged by performing organization.

OSIRIS

On Line Search Information Retrieval Information Storage

*Naval Material Command
Washington, D.C. 20360*

INTRODUCTION

Acronymology has become more than just a fad in the United States, especially in the Department of Defense where one needs a glossary to keep up with new terms. It seems that having a catchy acronym is more important than having a system to back it up. We must confess to adding one more to the list, but we hope in this case that both the acronym and the system prove equally appropriate.

The myth of Osiris, an Egyptian god, makes for an interesting analogy to information and information systems. Osiris was the son of Geb (the earth) and Nut (the heavens), and was the sum of all beneficent agencies. He was murdered by his brother, Set, and his body was torn into 14 pieces and scattered all over the earth. Isis, Osiris's sister, who undoubtedly conceived the first mythological retrieval system, then searched until she had found most of the pieces and she resurrected him. Osiris and Isis were married and she bore a child. Osiris then became king and judge of the dead and it is through him that all contacts with the dead in the underworld are made.

Surely we can consider information as the source of all human endeavors and that vast amorphous mass of information our civilization produces is certainly an underworld. In order to resurrect a particular item of information we must have help. This is precisely what this latter day OSIRIS attempts to do.

BACKGROUND

It is a fact of life that today every individual in the Naval Material Command has an information handling problem. Our managers must have information that is current, accurate, and succinct upon which to base their decisions. Our scientists and engineers must be made continually aware of new state-of-the-art developments so that they can take advantage of them in the design and development of new systems. Staff workers must be able to ferret out the intricate relationships among policy, applicable instructions, directives, and informal "drafts" in order to be responsive to requirements placed on them and also to be aware of what is going on in their working environment. Our message centers and mail rooms are tremendously taxed to keep up with the, at times, overwhelming volume of incoming material they must process. They are very hard put to handle the input much less worrying about better techniques for dissemination and storing the information for future reference. As the secretarial and clerical level, the picture is just as bad, the secretaries and clerks are all bogged down in filing and there is no immediate hope of relief using present techniques.

All of these people spend the majority of their time immersed in a continual flow of information and most of this information is in the form of documents ranging from a handwritten note to a 5000 page report. There are individual differences in the particular types of prob-

lems they face, but, in general, there are four basic aspects to information handling:

1. Input. How to organize, assemble, index, or somehow reduce the incoming information to a meaningful form and to fit it into current workload?

2. Processing. What to do with the information, how does it relate to previous information, and how might it relate to future items of information? What action must be taken as a result of receiving this information?

3. Output. What is the resultant of the process performed? Has a new item of information been generated as a result of processing or has the flow of information been terminated?

4. Storage. What is done with the information, either the input, the output, or both? What is the best technique for storing it for future reference?

All of these basic problems are included in the burgeoning new field of information sciences, and the most crucial problems are those dealing with Information Storage and Retrieval.

Many individuals and groups within the Command have come to, as in the past, and continue to contact us for help in solving the kinds of problems they face in dealing with the "information explosion." We have been able to apprise these people of what has been done, what is being done and what can be done in certain areas of applications similar to their own. We are able to cite, study upon study, to them, but we have found that it is very difficult for us to show them just how some of these potential applications would work in their own situations.

We have, therefore, reached the conclusion that what is needed is a practical demonstration of these potential applications in as nearly an operational environment as we could create with user participation and using real life information formats.

Test OSIRIS is intended to be just such a practical expression of the Information Sciences and Plans Branch's continuing search for better techniques, methods, and systems for acquiring, processing, storing, retrieving, and displaying information.

We hope that in conducting the test to give various groups within the Command first hand experience with some of the latest principles in information sciences using state-of-the-art technology and methodology.

In addition, it is hoped that in testing these principles, we may prove the feasibility and utility of many of them for future use. If this is the case, we hope to continue development of the system including both the hardware and the software involved for possibly wider applications within the Naval Material Command.

SYSTEM CONCEPT

The system concept was conceived and developed by A. Kenneth Showalter, Information Sciences and Plans Branch of the Naval Material Command. It is our feeling based on an appraisal of the current state-of-the-art in information retrieval technology that for large document handling systems microforms are the most efficient storage medium and the computer is by far the best search and retrieval device. This opinion seems well supported in view of the increased emphasis in microform storage capabilities and already well proven computer retrieval techniques.

The system we have chosen as a test vehicle embodies both of these concepts. We feel that the combination of the two results in an extremely powerful and versatile system. The OSIRIS system as it is presently configured has the following features:

- A large capacity microfiche file for document storage
- Remote random access video display of microfiche documents
- Random access mass computer storage
- A remote time shared computer terminal

Possible later additions, all of which are commercially available include:

- Multiple computer terminals and video displays
- A single terminal for both video and data display
- Remote and on-site hard copy generation
- Time-shared video disc, drum, or tape storage
- Broad band data, voice, and video transmission
- A 200,000 card capacity file

- Digital transmission of video over single phone lines

- English language type computer terminal queries

The strategy we are employing in testing the system (Fig. 1) is to use the microfiche

storage retrieval and display system for various types of full document files and to store the indices and abstracts on a random access computer file. We have invited potential users of such a system from our Command to store sample document files in the system and to access their material on the video monitor using either manual or computer retrieval techniques.

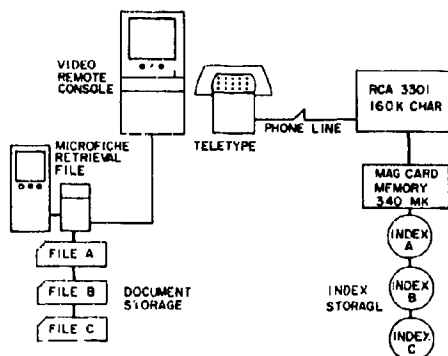


Fig. 1 - OSIRIS Configuration.

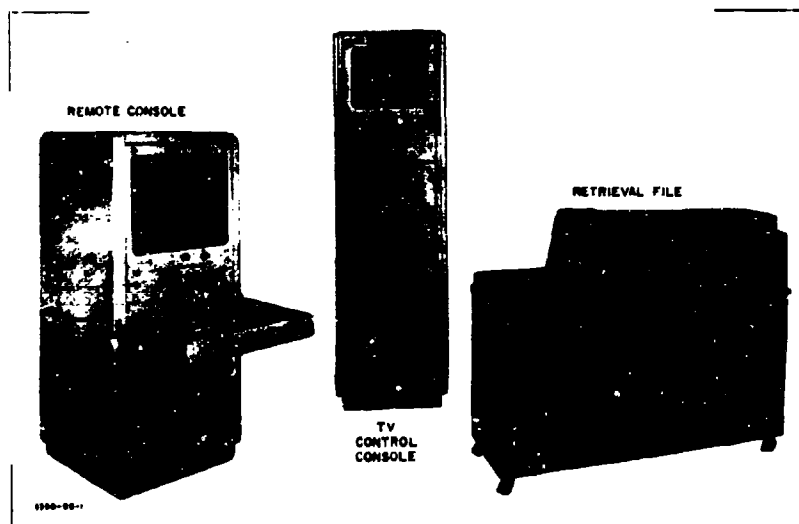


Fig. 2 - Graphic Data Storage, Retrieval, and Display System.

Using the computer terminal, the user will conduct his search in the usual interactive manner using Boolean search techniques by subject, keyword, author, and so on. He will be able to list either the title or abstract of those documents which seems to satisfy his request along with the microfiche file location number. It is at this point that the OSIRIS system goes one step further than most retrieval systems in that it allows the user to review the final product, the actual referenced document, "on-line."

SYSTEM OPERATION

Figure 2 shows the automated microfiche storage retrieval and display system. The retrieval file stores 5,000 microfiche on aperture cards in a rotary drum having 50 bins with 100 cards in each bin. In Fig. 3, an exposed view shows the drum, the X-Y platen which receives the card during retrieval, and the TV camera. There are two display monitors on the System,

one a 17 inch TV located with the central file and a remote console with a 21 inch screen. Any one of the cards can be accessed and any portion of it televised and magnified from 5 to 250X from either the central file console or the remote console which is cabled to the retrieval file.

Figure 4 is the remote console with controls and indicators. To retrieve a card containing a document to be viewed the operator takes the index number he has received as a result of a manual or computer search and keys it in on the keyboard (example 4671, bin 46, card 71). He then depresses the left, center or right platen position button #12 depending on which area of the card he wants to view. Next he depresses the Search button #10 and the retrieval cycle begins. The drum will revolve to the selected bin (00-49) and then the selected card (00-99) will be forced up into the glass X-Y platen in front of the camera lens. Once the card or microfiche is in the platen the op-

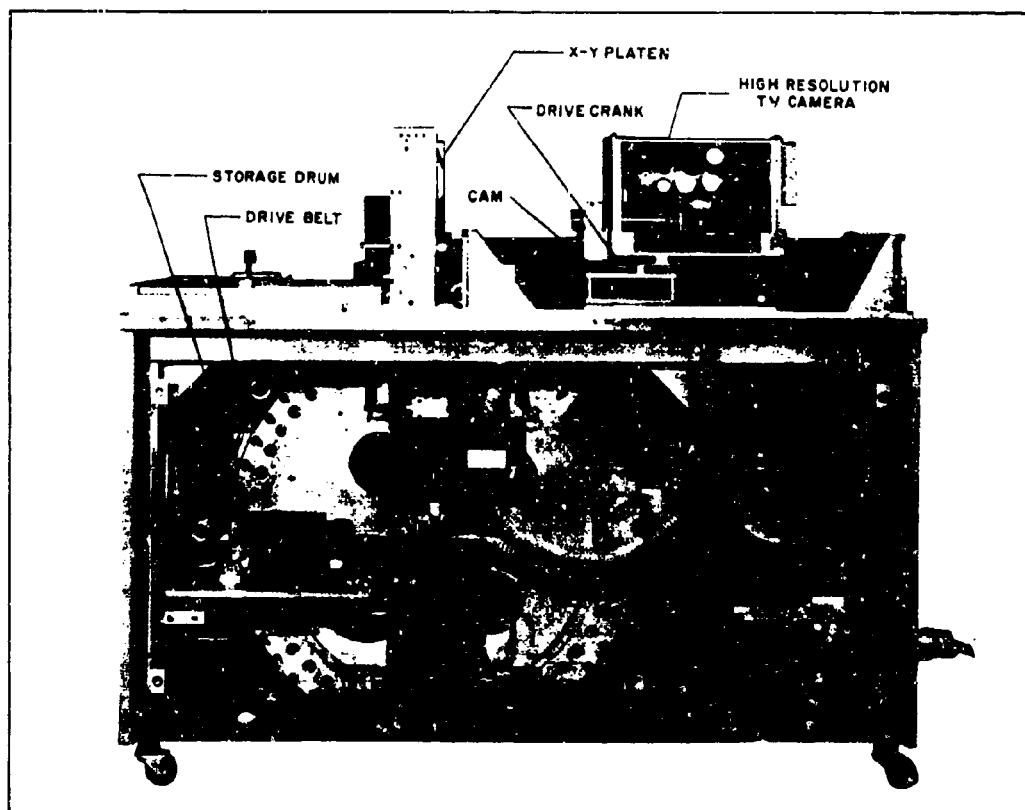


Fig. 3 - Right Inside View of Retrieval File.

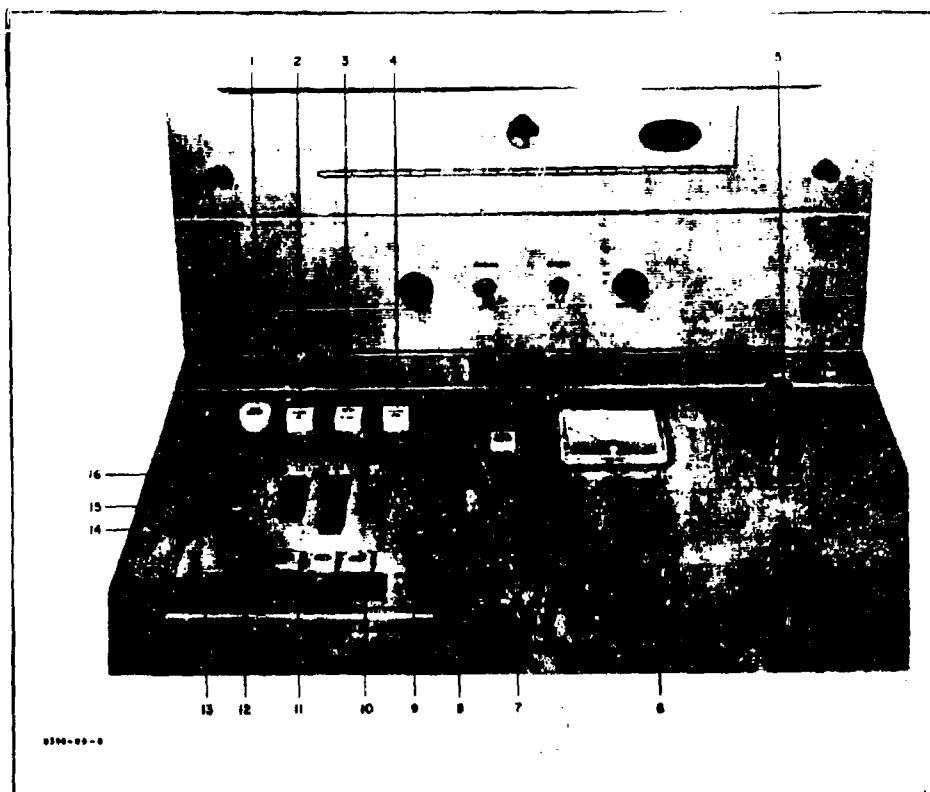


Fig. 4 - Remote Console, Controls, and Indicators

erator can move the card in any X-Y direction by manipulating the joystick control #5 and by turning the knob he can zoom the camera in and magnify any portion of it from 5X-250X. Once the operator is finished viewing, he depresses the Return button #11 and the card is returned to the file.

TEST RESULTS TO DATE

The retrieval file was originally designed for photographic storage, but we felt it had even greater potential for textual and graphic material and acquired it from the original user for this purpose. It has not been in extensive use the past year or so and we have experienced considerable delay in getting the system in perfect operating order. In addition, the "on-line" computer terminal installation has been fraught with the usual problems. We have, however, been able to conduct limited tests with a wide range of material and the results are extremely encouraging. Probably the most interesting discovery is in the range of microfiche reduc-

tion ratios the system can display. Standard reduction ratios are on the order of 10-45:1. In this range alpha-numeric text, greytone, and graphic material are as legible on the screen as the original hard copy. That the system can also blow back legible reproductions of high density microfiche with reduction ratios as high as 260:1 is phenomenal. With standard ratios it is possible to store 20 to 300 8-1/2" x 11" pages on a microfiche, using a 260:1 reduction ratio, it is possible to store over 10,000, giving the file a capacity of 50,000,000 pages. Although we are not able to bring this high density material back to its original size with this camera, the manufacturer can modify our existing system to give us a 500X magnification capability which should be more than adequate and possibly further extend the reduction ratio capability.

Another pleasant discovery is the remarkable clarity and ease of viewing a TV display of microforms allows. The combination of the joystick movement, zoom magnification, and a reversal switch for changing a negative to a positive image make it possible for one to re-

view and read documents on the TV monitor for a considerable period without any fatigue. In fact the TV display is far superior to most optical microform viewers we have had experience with. A poor quality microform can also be enhanced with the use of the camera and monitor controls so that the display is actually better than the original.

We are very encouraged by the results of the initial tests for they indicate that the system has capabilities beyond those of many current systems, and we have not yet fully explored its potential applications by any means. We are now in the process of microfilming other users' documents for additional storage in the system. We plan to have computerized indexes to these files in operation by this Fall.

First Navigation Trainer With a Digital Computer

*Naval Training Device Center
Orlando, Florida 32813*

Pioneers in the simulation field since the early 1940's, the Naval Training Device Center (NTDC) has continuously strived to keep training device standards abreast of recent scientific technology. One example of their success in this endeavor is the latest addition to the Navy's simulator inventory—the Operational Navigation Classroom Trainer, Device 1A22, the first fully digital navigation trainer. The functional requirements for the trainer was formalized into an engineering specification by the Naval Training Device Center. The Otis Elevator Company, Reflectone Division developed a trainer from the specification which uses a digital computer as the computation mechanism. Other functions such as engineering design review, evaluation, and acceptance were also performed by NTDC before the device was released to the Navigation School, Naval Air Station, Corpus Christi, Texas.

The classroom trainer presents to as many as 32 student navigators a synthesized global environment for practicing many different methods of air navigation. The classroom is effectively a flying aircraft in which the dynamic use of simulated air navigation instruments allows the students to develop their skill at several different navigation techniques. These various navigation techniques include: basic deadreckoning, pressure pattern navigation, celestial navigation together with observations of Polaris and the Sun, electronic navigation such as automatic radio direction finding, Consolan and Loran A, and driftmeter techniques. Because the techniques are simulated

PROGNOSIS

It has become apparent to us as well as to many other information system designers that the computer alone cannot solve all our problems. Just as methodological solutions require a multi-disciplinary approach technological solutions may also require a multi-media information handling system such as the combination of TV, microforms, and a computer. Industry and science present us with new capabilities almost daily. It is imperative then that the systems designer be aware of these capabilities, so that he may evaluate their utility and potential system applications. We feel certain that systems similar to OSIRIS will be developed in the next few years, and we hope our efforts will have helped in the development of these systems.

simultaneously, solutions to approximately 100 equations contained in the mathematical model must be calculated in a fraction of a second.

This requirement for high speed, high precision solutions of so many equations, precluded the economic use of conventional analog computations. After conducting a survey of available digital computers, Reflectone selected the DDP-116, manufactured by Honeywell's Computer Control Division. Major factors influencing the decision were word length, maximum internal memory size, memory cycle time, instruction execution time, availability, and, of course, price.

COMPUTER PROGRAMS

The major component in the trainer is the digital computer with its programs. The computer program is an on-line, real-time package with the capability of simulating a navigational environment. It was coded in DAP, the standard DDP-116 assembly language. Functions that are integrated over time are calculated in double precision because of the accuracy requirements. Single precision is used for all other calculations because of memory space and time requirements. The computer is equipped with a hardware multiply/divide option (in order to minimize the time required to perform the lengthy celestial calculations) and an on-line ASR-33 Teletype.

The executive program, which controls calculation of all flight parameters, celestial data,

and radio station information, is cycled in an iterative manner. It may be thought of as a large "do loop" where the start of each "loop" is signaled by a real-time clock. The number of "loops" executed times the period of the real-time clock is equal to the total flight time. Once during each "loop," a subroutine outputs up-to-date information to the peripheral equipment and inputs data from the trainer control panel. The frequency of the real-time clock is 8 Hz. This frequency is slow enough to allow all calculations in one period yet fast enough to provide insignificantly small changes in data. Thus, all instruments and other peripheral equipment appear to move smoothly as in an actual aircraft.

The executive routine follows the sequence of equations contained in the mathematical model while calling up the appropriate subroutine as the "loop" proceeds. At the end of each "loop," control panel sense switches are interrogated in the event a change in operating mode is requested.

The math library contains a number of subroutines which are frequently called to perform calculations. Subroutines included are square root (x), sine (x), arc tan (x), e, and cos (x). They are programmed using standard programming techniques.

Some other subroutines necessary for efficient operation are character input and output from the teletype, rounding routines, angle limit routines, and format conversion.

OPERATION

The realistic presentation of navigation equipment in two classrooms simulates a flying aircraft. The student navigators are monitored by one or more instructors while the trainer is under control of the trainer operator. The trainer operator receives the flight plan from the instructor prior to take off so that the instructor can spend his time observing the students and answering questions.

The sense switches control requests for additional flight information, for halting and initializing, for insertion of the initial flight conditions, for performing a software and hardware self-check, and for a routine used for program debugging.

These self-check routines are analogous to the preflight checks that a pilot performs before take off. The computer will make a GO/NO GO check on its internal program and then cycle in

a subroutine that outputs known values to instrument, radio, and celestial hardware subsystems.

The trainer operator need only compare these values with a checklist to verify a hardware ready condition. He then requests insertion of the initial flight conditions. These conditions include blocks of data such as meteorological, gyro, aircraft, radio beacons, Consolan Stations, Loran A Stations, Sun, stars, and the starting time. The above information is entered on the teletype in a question and answer manner between the computer and the trainer operator and thus provides an automatic checklist.

The instructor can then notify the trainer operator when the flight is to begin. The start and time-freeze buttons on the trainer control panel allow the aircraft to be stopped temporarily for intermissions or critiques on long flights. In-flight changes can be entered on-line with the teletype.

For post-problem evaluation, log entries of latitude, longitude, and time are printed every minute on the teletype. However, additional flight information can be requested. In this case, latitude, longitude, and time are printed every minute along with heading, speed, altitude or other data.

Aircraft controls are located on the trainer control panel where the operator can change any inputs as if flying the aircraft. These controls are Turn Rate, Climb or Dive Rate, Indicated Air Speed, Heading and Gyro Mode (free gyro or compass controlled directional gyro). Any type of aircraft can be simulated, as far as the above parameters are concerned.

Sense switches are also used to halt the program at the end of a "loop" and initialize it for proper starting.

For system analysis a debug routine can be selected. This routine performs many functions that are useful to the maintenance personnel. The functions that can be selected with the aid of the ASR-33 Teletype are relocating a block of memory, setting a break point, changing a block of memory, dumping a block of memory, execution of a subroutine via a jump store instruction, fixing a break point, look and change a single memory location, search memory for constants or effective addresses, type data into sequential locations, and run to the executive program.

Diagnostic programs can be entered into the computer by maintenance personnel via the

paper tape reader on the ASR-33 Teletype. These programs are designed to check various parts of the computer such as the memory, main frame instructions, the multiply and divide option, the ASR-33 Teletype and the I/O bus. The diagnostic routine isolates and identifies any failure.

HARDWARE

The trainer provides simulation in two classrooms with the following major assemblies: operator station and computer, eight student celestial observer stations, two classroom instrument display panels, two Loran A time difference indicators, two classroom radio aids panels, and two optical driftmeter simulators.

A large instrument panel with six oversized navigation instruments is located in the front of each classroom. The Loran A time delays are digitally displayed at the bottom of the instrument panel. Adjacent to this panel is a radio aids panel with a tunable receiver and bearing indicator. The star simulator booths are located in the rear of each classroom. There are four observer booths in each classroom. Each contains a periscopic sextant, magnetic compass, gyro, and clock. A star simulator is located over each sextant. A sliding curtain can be pulled across the door to darken the booth when the student is taking star shots.

The computer, teletype, and interface cabinet are located in one classroom, such that the trainer operator can view the instruments at the front of the room. The front panel on the interface cabinet contains aircraft controls, driftmeter controls, radio tuning controls and call letter patch boards, and a continuous readout of aircraft latitude and longitude.

The computer is an unmodified DDP-116 and is equipped with a hardware multiply and divide option in order to decrease multiplication time by a factor of 25 and division time by a factor of 20. The 1.7-usec memory contains 4096 words of 16 bits, divided into eight sectors of 512 words each. An ASR-33 Typewriter with an input/output rate of 10 characters per second is suitable for communication with the computer, since the navigation programs are stored in memory from day to day and during a flight only occasional on-line changes are necessary.

Between the computer which generates the solutions to the math model and the student who practices navigation techniques is a considerable amount of hardware arranged into subsystems.

The hardware solution of using a digital computer for navigation simulation is discussed on a subsystem basis of four main subsystems: input/output, star simulation, radio aids, and instrument subsystems.

The input/output subsystem design is a standard computer interface, that is, parallel transfer between the CPU and input/output registers. These are programmed transfers which are dependent on several control signals. The computer main frame generates the timing for the external addressing and control signals. All of the digital logic in the peripheral equipment is made up of printed circuit boards with hybrid integrated circuits.

Star simulation, a very important feature of Device 1A22, is an open loop servo system. A collimated light is positioned in the azimuth and altitude planes by two gear trains which are driven by servo step motors. The subsystem accepts the contents of the output register as a number representing azimuth or altitude angles. The number in the register is then counted down to zero. During this time, a pulse train is sent to a step motor which rotates its shaft to the desired relative angle. Each of the eight star observer booths has two of these open loop servo systems, one for azimuth and one for altitude. As the aircraft flies and the earth rotates, the star position changes. The computer outputs the incremental difference in position for updating the two servos. This is done at the program iteration rate so that each digital step of the step motor is insignificant to the observer. Three star magnitudes are available and are programmed as part of the teletype input star data. A larger image is automatically illuminated when the student selects the sun.

Radio aids are divided into three groups; radio beacon stations, Consolan Stations, and Loran A Stations. The computer makes a range comparison and blanks out those stations not in range.

The airborne radio compass equipment is basically a receiver comprising a band switch, vernier tuning dial, S-meter, and station bearing indicator. On the trainer control panel there is a similar band switch and vernier tuning dial for each station. When the student's bandswitch and tuning dial are coincident with any of the stations set up on the control panel, a comparator circuit sets a bit in the appropriate computer input register. The computer acknowledges this by loading an output register with a bit to deflect the S-meter and a station bearing number which positions the bearing indicator by means of a D/A converter and closed loop servo system.

The Consolan Stations are tuned by the student in the same manner as the beacon stations. The S-meter and bearing indicator are also active; however, a special method is employed to simulate the audio portion of the Consolan System. The dot and dash pulses originate from a digital counter. These pulses are used to gate a 1 kHz tone to the student receiver. The computer outputs a bearing number which is counted in the output register to determine how many dots and dashes the student should hear in each code group.

The enlarged classroom navigation instruments are 18 inches in diameter and are mounted at the front of each classroom. The six different instruments are; radar (or absolute) altimeter, barometric altimeter, indicated air speed with mach number, magnetic compass with gyro, free air temperature, and clock.

The clock uses a standard ac motor. Since the computer real time clock is also derived from the ac line, the classroom clocks and computer program are synchronous. A double time mode is available in order to advance the flight at twice the normal speed. This function is used on long simulated flights between infrequent position checks.

The other instruments share a common design. The output register for each instrument is connected to a D/A converter channel. The resulting dc voltage is converted, in a dc closed loop servo system, to the correct instrument dial reading. The magnetic compass and gyro deviate from the above design because they are continuously rotating instruments. They use a feedback pot with dual wipers located 180-degrees apart. Relay logic, which senses the four quadrants, switches from one wiper to the other so that the active wiper never passes through zero, where the pot is discontinuous. Although the standard driftmeter simulator is not physically similar to the instruments mentioned above, the same principle is used for the system design. The driftmeter is an ac analog device. Therefore, D/A conversion is again necessary to obtain the ac excitation voltages.

FUNCTIONAL DESCRIPTION

Device 1A22 offers training in several different navigation techniques which were mentioned at the beginning of this article. A brief description of these techniques may show how the trainer is used as a navigation teaching aid.

Dead reckoning which involves the determination of the ground velocity vector of an aircraft, is accomplished by deriving this vector

from true heading, true air speed, wind speed, and wind direction, and then projecting this vector forward for a selected period of time to provide a DR or assumed position. Device 1A22 deals with all this information including magnetic deviation and variation for corrections to compass readings; also pressure altitude, and air temperature for corrections to indicated air speed. The navigator can view large classroom instruments such as a barometric altimeter, air speed indicator, and air temperature indicator for making the true air speed calculations.

Pressure Pattern Navigation takes advantage of the known behavior of air masses as they move in high and low pressure areas. The trainer presents a dynamic pressure pattern by accepting wind speed and direction and their rates of changes as inputs and adjusting the differences in instrument indications accordingly, as the flight proceeds. The rate of change in wind speed and direction can be programmed in order to insure realism. With the incorporation of the correct air temperature indication, Pressure Pattern Navigation requirements are completely satisfied.

Polar navigation, where the magnetic field does not strongly attract the magnetic compass and the lines of longitude converge, requires special navigation techniques. In this area a single entry on the teletype will change the trainer to the Polar Mode, which means that the coordinate system is switched from spherical to rectangular. In this region, the navigator usually flies by his gyro. This mode is also selected by a teletype input.

Even though celestial navigation is one of the first techniques developed by man, it is one of the most important simulation areas of this trainer. The trainer is equipped with eight separate booths where eight navigators may simultaneously use their periscopic sextants to get a fix on seven different predestinated stars plus the Sun and Polaris.

The established table look-up techniques of celestial navigation require the navigator to start with an assumed position to the nearest degree. Once this is done, stars are selected which are visible at the assumed location and are approximately 120 degrees apart in azimuth. In the trainer, the navigator student enters an observer booth with the azimuth and altitude information for the optimum stars which he has selected from almanac data.

The booth is equipped with a periscopic sextant, compass, and a clock which is synchronized with the trainer. The navigator selects

the star he wishes to observe and the trainer responds by placing a simulated star of correct intensity at the exact azimuth and altitude. While the navigator is using his sextant to obtain the actual angles the trainer continuously updates the star position as the aircraft flies. After forming a triangle with the three star shots, the navigator can locate his position within a mile of his actual position.

Azimuth checks can be performed by selecting the Sun or Polaris depending on the hour of the day. Atmospheric refraction and coriolis effects are also included so that the student faces the same problems in the trainer as in a real-world situation.

Three different types of electronic navigation are simulated by Device 1A22. There are two receivers that simulate standard airborne radio compass equipment. A total of 10 radio beacon and Consolan Stations can be synthesized. In each classroom there is a display showing the station time delays which apply to Loran A Systems.

A radio aids panel in each classroom allows the students to tune in one of the Consolan Stations which he has located on his navigation chart. The receiver S-meter deflects when the station is tuned. Then he hears the station call letters followed by two sequences of a combination of dots and dashes. The navigator can establish a line of position, or bearing from the station, by counting the number of dots and dashes and locating on his chart the radial line from the station which corresponds to the dot/dash count. A bearing indicator is available to the student for a check on the correct quadrant. Repeating this procedure for another station establishes the intersection of two bearings or a fix.

The radio compass equipment uses the same radio receiver to tune in any one of the beacon stations. The radio compass indicates the bearing of the selected station is within range. The compass automatically positions itself to the bearing of the tuned station when the S-meter on the receiver deflects. The nav-

igator can identify the tuned station by reading the frequency on the receiver.

Loran A, the third electronic navigation method, is simulated by displaying in each classroom two time delays in microseconds. These are the delays between the Loran Station pairs selected. Once again the navigator must consult a chart showing Loran Stations and their time delay curves. A fix is obtained by utilizing the delays from two sets of Loran Station pairs.

The geographic positions of all the stations discussed above are entered using the on-line teletype. In addition, Consolan requires a line of tower reference and Loran requires a time delay constant. The frequencies of the stations to be tuned are selected at the tuning dials on the trainer control panel. Finally, the selection of the Consolan Morse Code call letter is inserted on five simple patch boards. Code generation is automatic.

The last area of simulation involves the derivation of ground speed and drift angle using a 1BN4 Driftmeter Simulator. A driftmeter is essentially a telescope which projects through the bottom of the aircraft and permits a navigator to watch the underlying terrain. Drift angle is determined by noting the angle at which an object on the ground passes beneath the aircraft and ground speed is determined by measuring how fast the object passes. Device 1A22 when connected to Device 1BN4, allows the student to use the normal techniques that the Driftmeter Simulator teaches. Day or night illumination and intensity are adjustable from the trainer operator's control panel. Drift angle and absolute altitude divided by ground speed are calculated at the computer and applied directly to a Driftmeter in each classroom.

It should be emphasized that all of these techniques may be practiced simultaneously by a group of navigators. Device 1A22 has again shown how a training device can be utilized to teach men to make the correct decision under stress. The application of a digital computer to a navigation trainer is now a proven design concept.

Versatile Digitizing System

Headquarters, Navy Pacific Missile Range
Point Mugu, California 93041

An Electronic Engineering Company digitizer system which has been installed in the Data Processing Department of the Pacific Missile Range is designed to digitize a variety of

sampling rates to adapt the digitization to the data frequency. The total sampling rate is 20,000 samples per second maximum. Input consists of one PAM (Pulse Amplitude Modula-

tion) signal, one PDM (Pulse Duration Modulation) signal or up to 20 continuous type information channels, all prerecorded on magnetic tape. Input data are converted to 10 binary bits and sign.

The digitizer provides accurate and flexible time-data correlation. The range time word for each sample time is written on the output tape in 17 bits of binary seconds and 10 bits of binary milliseconds. Standard IRIG (Inter-Range Instrumentation Group) time codes are accepted.

A successive approximation method is utilized for digitization. A sample and hold multiplexer supplies the proper channel for digitization and minimizes the time correlation problem by sampling all channels at the same instant of time.

The master clock may be the output of a crystal oscillator or may be controlled through

an AFC system by a special sinewave recorded on the data tape or by the IRIG standard time code signal.

There are two separate 4096 x 18 core memories. While one is accepting data from the digitizer, the other is connected to the output equipment. The output device is an IBM 729 VI Magnetic Tape Unit.

An auxiliary device called a Pulse Period Readout Unit measures the period of incoming data signals by writing on magnetic tape the time of each axis crossing of the input signal. The device has a resolution of 0.2 microseconds, and the percentage of cycles measured is limited by the data rate of the output tape unit. It can process up to six signals at a time; and is used for several types of signals, random pulses, monotonically changing frequencies and non-standard pulse code or pulse duration signals.

University-Level Computer Assisted Instruction

*University of Rochester
Rochester, New York 14627*

A study to determine effective methods of teaching large undergraduate science classes through computerized assistance is being conducted by the University of Rochester in collaboration with the State University of New York College at Geneseo.

Everett M. Hafner, professor of physics at Rochester, is directing the investigation under a \$46,100 grant from the Esso Education Foundation.

The project, according to Prof. Hafner, is aimed at "finding ways of teaching elementary science to large classes honestly and effectively, with limited professorial effort, and with attention to individuals.

"An essential step toward such goals is to make it possible for the instructor of a large freshman science class to redistribute his time. We'd like to help him get rid of routine house-keeping, and of the need to spend year after year teaching straightforward and heavily systemized material," he said.

"Then," Hafner says, "a professor might devote his entire teaching time to the labors that only he can perform: preparation of new material, association with students individually or in small groups, self-education, and cooperation with his colleagues.

"The computerized program, although similar to a heavily branched written program, does have important features that distinguish it. Among these are: variety in display, rapid acceptance of program change, concealment of unnecessary material, storage and processing of student performance, and access to remote equipment and material. We see the fast data processors as potentially powerful assistants to teachers of large groups, with special advantages for teachers of college science."

Initially, Hafner and his associates will gather and adapt appropriate samples of computer assisted instructional material already in existence. Students from Rochester and Geneseo will then test the material at terminal stations located on each campus and linked to a central computer system.

The grant was made under the Program of Support for Promoting the Utilization of Resources (SPUR), one of the Esso Education Foundation programs. To date, funds totalling \$809,174 have been awarded to finance 19 innovative projects in United States colleges and universities. The University of Rochester is the only institution to have been granted two awards under the SPUR program.

Prof. Hafner, a Rochester faculty member since 1953, was a former associate physicist with the Brookhaven National Laboratory.

Hospital Drug Usage

University of Southern California
Los Angeles, California 90007

The University of Southern California School of Medicine is doing rapid retrieval of data on drugs, with particular emphasis on a study of the incidence of adverse drug reactions. Now being used under actual working conditions at Los Angeles County General Hospital, the computer corrects misspellings, translates coded messages into readable form, and accepts information from authorized personnel only.

Project director, Dr. Robert F. Maronde, associate professor of medicine and pharmacology, said that before an assessment can be made of adverse responses, quantitative drug statistics must be obtained. "This information is naturally difficult to obtain in a large population," he said. "At County Hospital we have the advantage of knowing that some 90 percent of the drugs prescribed for patients are obtained by them from the hospital pharmacy."

County Hospital handles over 700,000 outpatient visits a year, and the pharmacy in the Unit I outpatient building, where the computer terminal is located, fills in excess of 10,000 prescriptions per week.

"At this stage of our study, while we are still training personnel in computer use, the pharmacists are entering a partial number of prescriptions into the computer system," Dr. Maronde said.

Information which includes the doctor's and patient's name, the drug ordered, dosage, and instructions for taking the medication, is entered into the system through a typewriter keyboard at the terminal. Using a code which the pharmacists devised, up to 26 symbols can be entered and up to 150 letters can be retrieved on a printed label.

When the pharmacist has entered the prescription in coded form, he presses a key on the typewriter which generates the information on a small screen, written out as it will appear on the label for the medication. If the image on the screen compares correctly with the physician's written prescription, the pharmacist instructs the computer to enter the information and return the label. Labels are recovered in strip form through another machine adjacent to the keyboard.

If the information on the screen is not right, the pharmacist can "type over" any line to make the necessary correction.

Over 700 drugs have been coded and programmed into the computer. Should the pharmacist not know the code number for a particular drug, he types the first two letters of its name and presses a "find" key. This causes all the drugs beginning with those letters to appear on the screen, together with their code numbers. The drug name may then be entered in one of several forms, but the computer will generate the generic name on the label.

State law requires that a licensed pharmacist must personally type the label and dispense the medication for every prescription. To fulfill these requirements, the pharmacist using the terminal must identify himself to the system with the code symbols assigned to him. The computer will accept information only from authorized personnel. Medication is dispensed by the pharmacist from the prescription label returned by the computer.

Dr. Maronde estimated that the use of this system will save about 75 percent of the time previously spent in typing, "and this is a valuable saving because there is a shortage of pharmacists," he added. "The computer will relieve the pharmacist of a tiresome chore and free him to devote his time to activities more appropriate to his training.

"While the prescriptions are being filled, we are also capturing essential drug information by patient and by quantity," the USC clinical pharmacologist continued. "We have rapid access to data on drugs prescribed for our patient-population, and each day we receive a summary print-out of all drugs entered through the terminal. We can call for this either alphabetically, or in chronological order beginning with the drug prescribed most often," he added.

When the system is fully operational for the evaluative study, which is being funded by National Institutes of Health and Connell Charities, drug information will be obtained on patients in a selected ward on the twelfth floor of County Hospital, where the computer system is located. "This is to be the pilot ward for the entire hospital for this type of computer application," Dr. Maronde said. "USC and County personnel will be working in close relationship. Our project and the County Hospital program, in fact, will tie in very well, since the hospital will have its own computer next year for application in the field of medical data retrieval."

Plans for using the system on the pilot ward are to collect all laboratory data and en-

ter it on computer files, by patient. The patient's file will also include diagnosis, drugs prescribed, usage, and comments by the attending physician regarding occurrences of adverse drug reactions.

"A computer system for the rapid retrieval of selected material can also be invaluable to the physician in improving patient care," Dr. Maronde said. "Existing hospital records are often bulky and cumbersome, and the information he wants may be scattered throughout the file." Another advantage of the computer, according to the USC physician, is evident when a patient reenters the hospital. A printed or display form of the tape containing his complete prior record is readily available to the physician for his perusal.

Dr. Maronde indicated that he expects the system to be in operation for all prescriptions filled at the Unit I pharmacy within a few weeks. "Eventually, we will be able to provide the physician with a summary list of all drugs prescribed, each time his patients come in," he said. "The computer is also being programmed to project, by patient, how long each prescription should last," he added.

USC is one of three test sites in the United States at which IBM has installed a computer system for this particular application. The medical school project employs a fulltime statistician, a systems analyst, consulting mathematician, several programmers and other personnel, as well as three systems engineers assigned by IBM.

U.S. Army Automatic Data Field Systems Command

Fort Belvoir, Virginia 22060

The Army Automatic Data Field Systems Command (ADFSC) commanded by Brig. Gen. Roger M. Lilly, began its third year on August 1, 1967.

Organized on a world-wide basis, ADFSC is a subordinate command of the U.S. Army Combat Developments Command, and the Commanding General, ADFSC, is also the Project Manager, Automatic Data Systems within the Army in the Field (ADSAF), so designated by the Commanding General U.S. Army Materiel Command. In his capacity as Commanding General, ADFSC, General Lilly represents the user, and as Project Manager ADSAF, the developer and supplier of the systems.

The mission of ADSAF Project is to develop, procure, and distribute the following systems for use within the Army in the field:

Tactical Fire Direction System (TACFIRE). This system provides for the introduction of a first generation automatic data processing system in the Army in the field which will increase the effectiveness of field artillery fire support through increased accuracy, better and greater efficiency in the determination of fire capabilities and the allocation of fire units to targets. TACFIRE development is currently completing a formal, competitive contract definition phase (LITTON, BURROUGHS, and IBM) leading to a Total Package Procurement in Dec. 1967, encompassing development, production, and early field support of the deployed system. A design goal of the development program is to provide a family of militarized general purpose ADP

equipment suitable for use by other Army tactical ADP systems.

Tactical Operations System (TOS). This system provides for the introduction of a first generation automatic data processing system into the Army in the field which will provide commanders and their staffs at field army and below with current, accurate information and intelligence for consideration in making operational decisions. TOS provides for ADP assistance in three areas of interest—operations (to include G-1 and G-4 summary information pertinent to the operations estimate); intelligence; and fire support coordination. Major developmental effort in this systems area is being accomplished in the Seventh U.S. Army under contract to Control Data Corporation who is to supply transportable ADP equipment. The equipment, including a Service Center (currently operational in Germany) will be used for the TOS development in Seventh U.S. Army, to assist in determining hardware and software requirements for an Army-wide Tactical Operations System (TOS). The contract provides for the first transportable data processing center and remote input/output devices to be delivered by late fall of this year. Headquarters ADFSC at Belvoir and its TOS Development group in Europe are providing technical assistance to Seventh Army.

Combat Service Support System (CS). This system is that portion of the ADSAF Project that addresses, through integrated automation, a computer supported logistics, personnel, and administrative system for the Army in the

Field. The ultimate goal of CS₃ is to integrate as many as possible of the functions of the G-1, G-4, G-5, and Comptroller into an ADP system and thereby relieve military personnel from these chores as well as improve the effectiveness of those functions. The system will provide Combat Service Support unit commanders with data leading to operational decisions based on best utilization of available resources; tactical commanders and their staffs with current, accurate information on the combat service support situation; and Headquarters, Department of the Army agencies, with information required for their missions. A CS₃ prototype test is to be conducted at Fort Hood, Texas, during fiscal year 1968, for which the III Corps has been selected as test organization. IBM was awarded the equipment contract for the CS₃ prototype and Seventh Army Inventory Control Center and delivery is scheduled for April-June, 1968.

In addition to the foregoing systems, the Project Manager is also responsible for the production and distribution of the Field Artillery Digital Automatic Computer (FADAC), Gun Direction M18, and associated equipment, to active Army artillery units world-wide; the

procurement, distribution, and introduction of a simplified automated supply accounting capability to Direct and General Support Units (DSU's/GSU's) Army-wide; provision of personnel for the Army Element of the tri-service TIPI-JSPO (Joint Special Program Office) engaged in developing the Tactical Information Processing Interpretation system for defense-wide use; assisting the Commanding General, U.S. Army, Europe, in the modernization of the Seventh U.S. Army Stock Control Center at Zweibrücken; and conduct of a field test at Fort Hood, Texas, on the ROAD Division Univac 1005 configuration, to determine the desirability and feasibility of automating certain functions on this equipment.

ADFSC field units include the TOS Development Group and CS Assistance Group in Germany; CS₃ Test Group at Fort Hood, Texas; New Equipment Introduction and Assistance Teams in Europe and Southeast Asia; a field office at Fort Lee, Va., and a detachment at Wright-Patterson Air Force Base. In addition, there are ADFSC liaison offices at Headquarters, Army Materiel Command in Washington, Army Electronics Command, Fort Monmouth, N. J., and U.S. Army, Frankford Arsenal.

Information Clearing House Study

U.S. Department of Health, Education, and Welfare
Public Health Service
Bethesda, Maryland 20014

The Public Health Service is exploring the feasibility of establishing a Center to serve as a clearinghouse for information on hospital automated communication systems.

Increasingly, hospitals are using computers to speed the exchange of information between individual departments, such as admitting, business office, nursing, pharmacy and others relating to patient care. The Center would gather and analyze the data relevant to this rapidly developing field so that Public Health Service consultants will be better prepared to advise hospitals throughout the Nation on their computer applications.

Noting that automated communication systems have great potential for increasing the efficiency, economy, and effectiveness of hospital operations, Dr. William H. Stewart, Surgeon General, said, "These systems in hospitals are proliferating rapidly in the midst of constant technological change and development. If public funds are to be prudently expended in this area, a comprehensive source of information on these systems and the current state-of-the-art is essential. Our objective is to help hospitals avoid

the many problems and pitfalls to be encountered in this fast-moving science."

A 6-month study to determine technical and management requirements for the Center is being supported by a \$29,386 research contract executed by the Division of Hospital and Medical Facilities. Herner and Company, consultants in information science, Washington, D. C., will conduct the study.

Dr. Stewart added that the study is designed to provide various by-products such as a list of information sources on automated communication systems, a bibliography of the literature, and questionnaires for surveying automated communication activities in medical care facilities.

Clayton Pierce, Communications Specialist, Division of Hospital and Medical Facilities, is project officer. This Division, directed by Assistant Surgeon General Harold M. Graning, administers the Hill-Burton Program which, among other activities, promotes research to improve health facilities and services.

AUTODIN Expansion

*U.S. Naval Communication Station
FPO San Francisco 96613*

A completely new era of communications was introduced to the Hawaiian area on 3 April 1967 when the United States Naval Communication Station at Wahiawa officially activated their Automatic Digital Integrated Network (AUTODIN). Captain Warren H. Wettlaufer, USN, Commanding Officer at the communication station, put the network into operational status when he sent the first message over the channels to Washington, D. C. It read: "Aloha from Hawaii AUTODIN."

Captain Robert S. Downes, USNR, a director of the Naval Communication System Headquarters in Washington, was the principal speaker at the ceremony held at Wahiawa, which was attended by representatives from high military commands throughout the United States, executives from Western Union Telegraph and Radio Corporation of America, as well as local political figures. Captain Downes emphasized that "the activation of AUTODIN in Hawaii is a significant advancement in the Defense Communication System throughout the free world and even further enhances Hawaii's position as the military nerve center of the Pacific."

AUTODIN is a world-wide network composed of individual Automatic Electronic Switching Centers in various geographic locations. At present there are nine such centers in the continental United States. The recently activated one at Wahiawa is the first outside the continental United States and the third under direct control of the Navy. There are currently others under construction or in the planning stages overseas.

The switching center at Wahiawa is managed and operated by the United States Naval Communication Station, Honolulu for the Defense Communication Agency. It is responsible for the handling of communication data and quality control of circuits throughout the Pacific and maintains inter-connecting trunk circuits with continental United States centers and other manual data Relay Centers in the Western Pacific. It will provide the Navy, Air Force, Army, Coast Guard, other government agencies, and industrial contractors with a world-wide, high-speed, automatic, electronic, computerized data communication service. It is designed to link about 3,500 such installations within the year, and will eventually replace all manual and torn-tape relay stations in the world.

More specifically, the system will provide direct user-to-user service, store and forward message service, compatibility of media codes, speeds and formats, automatic error detection and correction, message processing by priority, maximum security against compromise, and will automatically route to alternate addresses on a message.

The significance of the system can be best understood by considering a few examples of its capabilities. To send a message from, say, Vietnam to Washington, D. C. normally would take many hours or, more likely, many days; however, through the use of AUTODIN, this message would be received in Washington in less than 5 seconds after it was put on the wire in Vietnam. At present the United States Naval Communication Station at Wahiawa, which is the largest communication station in the world, handles approximately 8 million messages annually. With the activation of their new switching center, this handling capability will be increased to over 70 million messages per year. By eliminating the need for human hands to process a message at each station enroute to its final destination, this system can effect such rapid delivery in mass volume.

The system was first conceived in 1958 by a Special United States Air Force Planning Group. Its activation as a replacement for several manual data networks was completed in 1963. Upon its activation with its five switching centers, the network was adopted by the Defense Communication Agency as the nucleus of a planned world-wide system. Since that time it has expanded to include all services.

Reed and Martin Contractors, Honolulu were awarded a 2.5 million dollar contract to begin construction at the 22,000-sq. ft. Wahiawa location in March 1966. The installation of equipment was initiated on 1 October of that year under the direction of Western Union and RCA, the prime contractor and major sub-contractor, respectively, for the entire AUTODIN program. Once installation was completed, testing was begun and then, on 3 April the center went operational.

Lieutenant William A. Tanner, Jr., USN, has been appointed to head the Wahiawa system, while more than 100 civilians with a combined salary of 1.5 million dollars, man the facility.